PATENT SPECIFICATION

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DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Motor Vehicle Transmissions

We, FORD MOTOR COMPANY LIMITED, of 88 Regent Street, London, W.1., a British Company, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to motor vehicle transmissions.

Where it is required that a large number of gear ratios should be available in a motor vehicle transmission it is usual to provide the vehicle with a two-speed axle and a multi-speed gearbox. For example a five speed gear-box and a two-speed axle give ten different speed ratios. With a four-speed gear-box there would be eight different ratios. In some gear ratio changes, for example from a high-second gear (second gear and a high axle ratio) to low-third gear (third gear and low axle ratio) it is necessary to change both the axle ratio and the gear-box ratio; for other ratio changes e.g. from low-third to high-third only the axle ratio is changed. This can lead to confusion and selection of the wrong gear.

Generally speaking more widely spaced gear ratios are required with the lower gears than with the higher gears, but with the usual system in which the axle ratio splits the gear-box ratios, i.e. provides an additional gear between each pair of adjacent gear-box ratios, the high gear ratios must be widely spaced if the axle ratio is to effectively split the gear-box ratios.

One way to overcome this problem is for the axle to split the gear-box ratios at the low gear end and for the gear-box ratios to split the axle ratio at the high gear end. For example, the sequence of increasing gear ratios could be low-first, high-first, low-second, high-second, low-third, high-third, low-fourth, low-fifth, high-fourth and high fifth. This kind of sequence requires changes in axle and gear-box ratio for some ratio changes; changes in the axle ratio only, for other ratio changes and changes in the gear-box ratio only for still other ratio changes. This adds to the confusion caused to the driver and to the chance of the wrong ratio being selected.

The invention is described in this paragraph. A motor vehicle transmission has all the following characteristics in combination:

a) the transmission incorporates a first variable speed ratio device capable of driving with any of more than one forward speed ratio and a reverse speed ratio;

b) a second variable speed ratio device is arranged in series with the first variable speed ratio device and is capable of driving with any of more than one forward speed ratios;

c) the operative speed ratio of the first variable speed ratio device in the transmission is controllable by electrical signals;

d) the operative speed ratio of the second variable speed ratio device in the transmission is controllable by electrical signals; and

e) a control system is adapted to provide electrical signals to control the operative gear ratios in both variable speed ratio devices by movement of a single manually operable control in the control system between a series of discrete positions each corresponding to a respective overall gear ratio.

Further features of the invention are described in the appended claims.

The invention is particularly described with reference to the accompanying drawings in which:

Figure 1 is a plan view of a gear-box ratio selector mechanism;

Figure 2 is a diagram of a gate showing the positions to which a selector lever is moved to select a particular overall speed ratio;

Figure 3 is a diagrammatic plan view and electrical circuit diagram of a control system for a gear-box and two-speed axle;

Figure 4 is a side view of the control system of Figure 3, showing only some of the components; and

Figure 5 is an end view of the control sys-

tem of Figure 3 showing only some of the components but also showing additional operating linkage.

The gear ratio of one currently available two-speed axle is selected by electrical signals to change from one ratio to the other.

An electrically controlled pneumatically operated gear selector mechanism is also available for a five speed and reverse gear-box.

This embodiment of the invention is a control system for these selector mechanisms which enables a driver to select the overall gear ratios by a simple sequence of movements of a single control lever.

GEAR-BOX SELECTOR MECHANISM

Sufficient details of the gear-box selector mechanisms for an understanding of the control system are shown in Figure 1. References 1, 2, 3, 4, 5 and R represent the positions within a gate 11 which should be occupied by a gear-box selector lever 12 for each of the five forward and one reverse gears to b eselected. A double acting pneumatic piston and cylinder assembly 13 is operated to select the 1—R plane or the 4—5 plane or the 2—3 plane. A second double acting pneumatic piston and cylinder assembly 14 is operated to select the fore and aft position of the lever 12 to engage gear ratio 1, 3 or 5 in the forward position, or neutral in the central position or gear ratio R, 2 or 4 in the rearmost position. The operation of the two piston and cylinder assemblies is controlled by a series of solenoids (not shown) which respond to electrical signals the production of which will be explained below.

AXLE RATIO SELECTOR MECHANISM

The two speed ratio axle includes a motor that is energised in one sense to engage one of the ratios and in the opposite sense to engage the other ratio. There is no neutral gear available in the axle assembly. Limit switches associated with the motor ensure that current is cut off once a change in ratio has been effected; this prevents overheating of the motor and also excessive current drain.

GATE LAYOUT

Figure 2 shows a convenient gate layout for selection of the ten forward gears and one reverse gear by a single control lever. The gear-box ratios are represented by references 1, 2, 3, 4, 5 and R and the axle ratio by a prefix L or H (low or high). The ten forward gears are arranged in a sequence of increasing ratio so that each up-change to the next higher ratio is performed by either a movement of the control lever from a forward to a rearward position, e.g. from L2 to H2, or by a movement forward and to the right from a rearward position, e.g. from H2 to L3. There is a corresponding simple sequence for down-changes. To prevent inadvertent movement across the gate, e.g. to L4 instead of L3 from H2, the neutral planes of the gate are inclined as shown. If it is intended to miss some gears out in a sequence of gear-changes, e.g. from H2 to L4, this is possible by careful manipulation of the control lever.

COMBINED SELECTOR MECHANISM

The references used in Figures 3 and 4 represent the functions of the components indicated.

The first letter of each reference indicates the kind of component as follows.

L — electrical lead
S — electrical switch
B — selector bar
R — relay.

Subsequent letters and numbers represent the gear ratios with which the component is concerned, using the same references L, H, R, 1, 2, 3, 4 and 5 for the gear ratios:

For example: S2R4 is a switch (S) associated with second gear (2) reverse gear (R) and fourth gear (4) in the gear box. Similarly L L is a line (L) associated with low axle ratio (L) and L 45 is a line associated with fourth and fifth gears in the gear-box.

Some selector bar references end in A or B. This is to distinguish two selector bars associated with the same gear ratios. For example B135A and B135B are two bars each associated with first, third and fifth gears in the gear-box.

Switches.

The switches S . . . are all change-over micro-switches. The central lead is the common supply lead, the upper lead is connected to the supply lead when the switch is closed, (i.e. operated by one of the selector bars B . . .), and the lower lead is connected to the supply lead when the switch is open.

Selector lever and block.

The structure illustrated in Figures 3 and 4 will now be explained. A selector lever 21 is mounted on a selector block 22 which is in turn mounted for rotating and sliding motion on a fixed central shaft 23. The lever 21 extends in both directions from the selector block and may be operated directly by a knob (not shown) on its upper end or remotely from its lower end by a linkage to be described subsequently with reference to Figure 5. As shown, the lever 21 extends up a small distance through a gate plate 24 shown in Figure 4. The gate 25 formed in the gate plate 24 is shown in outline in Figure 3. When there is no operating knob on top of the lever 21 the position of the top of the lever 21 in the gate 25 indicates the gear ratio selected.

Selector bars.

There are selector bars at three different levels. Those at the high level, e.g. BHA (Figure 4) are operated by the top of the lever 21 when it is in a lateral plane occupied by the bar concerned and is moved either forward or back as the case may be towards the bar. There are further selector bars at a low level, e.g. BHB. These are similar to the bars at a high level except that forward lower bars

are operated by the same movement of the lever 21 as rearward upper bars and *vice versa*. The only reason for both upper and lower bars is to overcome a problem in packaging all the bars at one level. There are also selector bars at a central level. These are operated by the selector block 22. Because of their central position they operate independently of backward and forward movement of the lever 21: they respond to lateral movement along the central shaft 23 of the block 22. Selector bar B23 is operated when lever 21 is in the L2 — H2 plane or the L3 — H3 plane or the intervening neutral Selector bar B1R is operated when lever 21 is in the L1 — H1 plane or the reverse plane or the intervening neutral. The central selector bar BN has four projections 26 which extend towards the selector block 22. The selector block 22 has a corresponding projection 27 which engages one of the projections 26 when the lever 21 is moved between any of the planes R, L1 — H1, L2 — H2 or L3 — H3. As shown the selector lever 21 is between the L2 — H2 and L3 — H3 planes and is operating the selector bar BN. This arrangement ensures that the selector bar BN is operated only when the lever 21 is moved from one plane to another.

Figure 5 shows more structural details of the rearward selector bars. The bar B2R4A is in three parts. The larger part is supported on two arms 28 and 29 which are fixed to a tube 31. The two smaller parts are supported on arms 32 and 33 which are in turn fixed to tubes 34 and 35. The three tubes 31, 34 and 35 are held by pins 36, 37 and 38 on a shaft 39 so that all three parts of the selector bar B2R4A pivot in unison about the axis of shaft 39. Two further tubes 41 and 42 on the shaft 39 support two further arms 43 and 44 and these arms in turn carry the two parts of the selector bar B135A. The two arms 43 and 44 are joined by a cross member 45 so that they pivot together; the tubes 41 and 42 are a running fit on the shaft 39 so that the bar B135A pivots independently of the bar B2R4A. In a similar way the two parts of the selector bar B135B are supported on arms 46, 47 and 48 and tubes 49 and 51. The tubes 49 and 51 are mounted on a shaft 52 by pins 53 and 54 so that both parts of bar B135B pivot together. The single part of bar B2R4B is supported on an arm 55 and tube 56, the tube being free to rotate on the shaft 52.

Switch Operation by Selector Bars.

The two selector bars B2R4A and B2R4B operate a common micro-switch S2R4 through a lug 57 on the arm 32 and a lug 58 on the arm 55. Similarly the two selector bars B135A and B135B operate a common micro-switch S135 through a lug 59 on bar 43 and a lug 61 on bar 47. Figure 5 also shows the selector bar BN. This is in one piece and is supported by two arms 62 and 63 from a tube 64 which is pivotable about its own axis. The selector bar BN bears directly on a micro-switch SN to operate it.

Remote Linkage.

The remote gear selector linkage is also shown in Figure 5. A gear lever 71 is supported on two lateral links 72 and 73 by pivots 74 and 75. The link pivot 75 is fixed against lateral movement (within the plane of Figure 5 by the link 73.) Thus, when a knob 76 on the lever 71 is moved laterally the pivot 74 also moves laterally and causes link 72 to slide the selector bar 21 and selector block 22 (Figure 4) laterally along the shaft 23. This moves the selector block from plane to plane within the gate 25 (Figure 3). The link 73 is pivotable about an axis 77 which is common with the axis of the selector block 22. When the gear lever knob 77 is moved backward or forward the whole linkage constituted by gear lever 71, links 72 and 73, and selector lever 21 all pivot about the axis 77 thus moving the selector lever forward or back within a plane of the gate 25 (Figure 3). Thus movements of the gear lever 71 are reproduced as movements of the selector lever 21 within the gate 25.

Master Switch.

Figure 5 also shows details of a master switch MS in the gear lever control knob. This master switch controls the electrical supply to some of the switches S . . . as will be explained in the operation of the whole gear change mechanism. Two wires 78 and 79 lead in to the gear lever 71 and pass up the gear lever to terminate in two contacts 81 and 82 mounted in an insulating contact plate 83 fixed to the top of the gear lever 71. The knob 76 is made of insulating material and carries a metal disc 84 above the contacts 81 and 82. The knob 76 is mounted on the lever 71 in such a way that it can float up and down on the lever to a small extent. A spring 85 urges the knob 76 into its upper position and thus holds the disc 84 away from the contacts 81 and 82. When the driver of the vehicle intends to change gear, he exerts a downward force on the knob 76 and thus causes the disc 84 to bridge the contacts 81 and 82 and closes the master switch. This ensures that while a driver is changing gear the master switch is always closed.

Leads to Gear-Box and Axle.

The output leads L . . . from the switches S . . . are connected as appropriate to either the control system of the pneumatic piston and cylinder assemblies or the control system of the two speed axle. The connections are such that the axle or gear-box is set to the position indicated by the reference used for the line L . . . and the switch S . . . when a signal appears on the line concerned. For example if line LH carries a signal, this signal is supplied to the axle shift unit and causes high

ratio (H) to be selected; if high ratio is already engaged the signal maintains high ratio in engagement.

Line signal production by selector bar operation.

The following table indicates the selector bars which are operated, the switches which are closed and the lines which carry a signal, for each ratio.

Ratio	Selector Bars			Switches			Lines		
	Axle	Plane	Fore/Aft	Axle	Plane	Fore/Aft	Axle	Plane	Fore/Aft
R	BLA	B1R	B2R4A	SL	S1R	S2R4	LL	L1R	L2R4
L1	BLA	B1R	B135A	SL	S1R	S135	LL	L1R	L135
H1	BHB	B1R	B135B	SH	S1R	S135	LH	L1R	L135
L2	BLA	B23	B2R4A	SL	S23	S2R4	LL	L23	L2R4
H2	BHB	B23	B2R4B	SH	S23	S2R4	LH	L23	L2R4
L3	BLA	B23	B135A	SL	S23	S135	LL	L23	L135
H3	BHB	B23	B135B	SH	S23	S135	LH	L23	L135
L4	BLA	—	B2R4A	SL	—	S2R4	LL	L45	L2R4
L5	BLB	—	B135B	SL	—	S135	LL	L45	L135
H4	BHA	—	B2R4A	SH	—	S2R4	LH	L45	L2R4
H5	BHB	—	B135B	SH	—	S135	LH	L45	L135

Axle ratio selection.

The table and Figure 3 shows that there are two axle ratio selector bars, two corresponding axle ratio switches and two corresponding axle ratio lines. For any low ratio the low (L) selector bar, switch, and line are operated; for any high ratio the high (H) selector bar, switch and line are operated.

Gear-Box plane selection.

There are only two gear-box plane selector bars for three possible gear-box planes. Selector bar B1R and the corresponding switch S1R and line L1R are operated for reverse, low first and high first ratios. Selector bar B23 and the corresponding switch S23 and line L23 are operated for low and high second and

low and high third ratios. There is no selector bar for the fourth-fifth gear-box plane. When low or high fourth or fifth ratio is selected no gear-box ratio selector bar is operated. In this situation the supply voltage to open switch S1R is connected to the "open" output and from there to the supply input to switch S23. As S23 is also open the supply voltage appears at the "open" output from switch S23. It is only when switches S1R and S23 are open that the supply voltage reaches the open output of switch S2 and thus this open output is used for the L45 line to indicate that the 4—5 gear-box plane should be selected. This use of negative information (1—R and 2—3 planes not selected) is possible because even in the neutral state between any of the ratios R — L1 — H1 — L2 — H2 — L3 — H3 one or other of the selector bars B1R and B23 is operated. It follows that in neutral between any of the gears L4 — L5 — H4 — H5 the 4—5 plane remains selected by the absence of the operation of one of the selector bars B1R and B23.

Fore and aft gear-box position selection.

The table and Figure 3 show that there are three fore and aft selector bars, three corresponding fore and aft switches and three corresponding fore and aft lines. One or other of the in-gear fore and aft selector bars (B2R4 and B135) is operated when a gear is selected. This operates the corresponding switch S2R4 or S135 which in turn provides a signal on the corresponding line L2R4 or L135. The neutral selector bar is operated only when the selector lever 21 (Figure 3) is moved from one plane of the selector to another between any of the planes R, L1—H1, L2—H2, and L3—H3.

Neutral is also selected by the negative situation of the following four selector bars being unoperated: bars B1R, B23, B2R4 and B135. This additional neutral selection also requires the selector bar BN to be unoperated, but this is not considered a criterion of the additional neutral situation because operation of BN automatically selects neutral. As explained above under the heading "Gear-box plane selection" if selector bars B1R and B23 are unoperated switches S1R and S23 are open and a signal appears on the open output from switch S23, i.e. on line L45. An additional line LGBN leads from line L45 to the winding of a normally open relay R45 so that when selector bars B1R and B23 are unoperated the relay R45 is operated. This completes a connection from the open output of switch S135 to the neutral line LN. Assuming that selector bars BN, B2R4 and B135 are unoperated, then switches SN, S2R4 and S135 are all open. As a result the supply voltage to switch SN is connected through SN to the open output, from there to the supply inlet of S2R4, through S2R4 to the open output, from there to the supply inlet of S135, through S135 to the open output, and from there through the closed contacts of relay R45 to the neutral line LN. Thus neutral is selected if the four selector bars B1R, B23, B2R4 and B135 are unoperated.

Reverse Gear Selection.

To select reverse gear the selector lever 21 is placed in the reverse gear position. This operates selector bars BLA, B1R and B24RA and thus selects low axle ratio, the 1—R gear-box plane and forward (2—R—4) gear-box position, i.e. reverse gear.

When the selector lever is moved out of reverse gear the gear remains selected until a positive action occurs to change the selected ratio. This does not occur until the selector lever is moved from the reverse plane in the gate to the L1—H1 plane in the gate. In passing between these planes the projection 27 (Figure 3) on the selector block operates the selector bar BN by means of projection 26 and thus selects neutral in the gear-box. The R—1 gear-box remains selected and low axle ratio remains selected.

Low First Gear Selection.

When the selector lever 21 is moved to the L1 position in the gate the selector bars BLA, B1R and B135A are operated. This selects first gear. If the gear previously selected was reverse, the axle ratio was already set to low, the R—1 gear-box plane was already selected and the only change is that the rear (1, 3, 5) gear-box position is selected in place of neutral.

To select neutral from low first the selector lever must be moved out of the L1 position and then moved across the gate until the projection 27 operates one of the projections 26 on the selector bar BN.

High first Gear Selection.

To select high first ratio from low first the selector lever 21 is moved straight back from L1 to H1. The R—1 gear-box plane and the rear (1,3,5) gear-box position remain selected. The only change effected is in the axle where the selector bar BHB is operated to select high ratio.

Neutral selection from high first gear is similar to neutral selection from low first gear.

Low Second Gear Selection.

To select low second after high first the selector lever 21 is moved out of high first and then across the gate to the L2—H2 plane. In moving across the gate neutral is selected by the projection 27 operating a projection 26 on selector bar BN. Also in moving across the gate selector bar B23 is operated and selector bar B1R is released. B1R is released before B23 is operated so that for a short time neither B1R nor B23 is operated and a signal appears on line L45, causing the 4—5 gear-box plane to be selected as explained above under the heading "Gear-box plane selection". Shortly after this selector bar B23 is operated so that

switch S23 is operated and a signal appears on line L23 to cause the 2—3 gear-box plane to be selected.

Once in the L2—H2 plane of the gate has been reached the selector lever is moved to the L2 position. This operates the selector bars BLA and B2R4A which operate switches SL and S2R4 and thus cause low axle ratio and the forward (2,R,4) gear-box position to be selected. This completes selection of low second gear.

Neutral selection from low second is similar to that from low first gear.

High Second Gear Selection.

High second gear from low second and neutral from high second are selected in a similar way to high first from low first and neutral from high first.

Low and High Third gear selection

Third gear selection (high or low) from second gear is similar to second gear selection. The 2—3 gear-box plane remains selected throughout.

Summary of Gear Selection within the range R, L1, H1, L2, H2, L3, H3.

Within this range neutral is selected from any one gear by moving the selector lever out of the gear position and the moving it across the gate. There are two primary groups of ratios: R, L1, H1 and L2, H2, L3, H3. Within any one of these groups the gear-box plane selector bar B1R or B23 remains selected and thus the gear-box plane remains selected. Each primary group can be sub-divided into two sub-groups: R; L1, H1; L2, H2; and L3, H3. Within each sub-group both the gear-box plane and the gear-box fore and aft selection remain unaltered; neutral is not selected during a change within a sub-group; the only change is in the axle ratio selected. Thus a gear change within one of these groups corresponds to operation of the axle ratio control on a vehicle with separate gear-box and axle controls.

Neutral selection on moving the selector lever across the gate between the L3—H3 plane and the L4—L5 plane corresponds to the general pattern within the range R . . . H3.

Gear Selection within the range L4, L5, H4, H5.

Within this range the general pattern of the ratios L . . . H3 is not repeated, partly because of the fact that L5 is a lower ratio than H4 and partly because there is no gear-box plane selector bar for the 4—5 gear-box plane.

In all the positions L4, L5, H4, H5, and all intermediate positions neither gear-box plane selector bar B1R nor B23 is operated. As explained above under the heading "Gear-box plane selection" this results in a signal on line L45 which in turn selects the 4—5 gear-box plane and also operates relay R45.

When the selector lever 21 is in the central position within the L4—L5 plane or the H4—H5 plane or an intermediate position between these two planes none of the selector bars BN, B2R4 or B135 is operated. Because relay R45 is operated this results in a signal on the line LN as explained above in the section "Gear-box Plane Selection". Thus neutral is always selected as soon as the selector lever 21 is moved out of any of the gears L4, L5, H4 or H5. This is necessary because within a single plane of the gate, either the L4—L5 plane or the H4—H5 plane a ratio change in the gear-box is required between fourth and fifth gears; in contrast, with the lower ratios, e.g. L2 and H2, movement of the selector lever 21 within a single plane results in a change of axle ratio and no change of gear-box ratio.

As for the lower ratios, in the group L4, L5, H4, H5 the same gear-box plane remains selected. Low or high axle ratio and fourth or fifth gear-box ratio are selected through the selector bars, switches and lines in dependence on the particular ratio selected by the selector lever 21.

Some necessary and desirable refinements not explained so far are incorporated in the overall system. These will now be explained in detail.

Electrical Current Saving.

To avoid unnecessary current consumption the overall system is arranged so that once a gear ratio has been selected, the current is switched off until another gear change is required.

In the commercially available two-speed axle this feature is already provided. Limit switches switch off the current as soon as a change in ratio has been effected. The previously described master switch MS, incorporated in the gear lever knob (Figure 5) is connected into the supply lines to the remaining switches S . . . i.e. in the lines to switches SN and S1R. This establishes the condition that the supply to the switches S . . . and thus the signals on the lines L . . . to the gear changing devices only appear while the weight of the driver's hand is on the gear lever knob. There is a possibility that a driver will move the gear lever quickly and will then release the switch MS before the ratio change in the gear-box has been completed. To overcome this problem an over-ride switch ORS is connected in parallel with the master switch MS. This switch is controlled from the gear-box and remains closed until a ratio change has been completed. Thus the master switch MS is bypassed until the ratio change is completed even if a driver removes his hand from the gear lever knob.

Sequence of operation of gear-box selector lever.

A movement across the gear-box gate cannot be carried out until neutral is selected and similarly a fore and aft in gear position cannot be selected until the correct plane has been

selected. An interlock arrangement is provided to ensure that these malfunctions cannot occur.

A "neutral selected" switch NS connected into the supply to the gear-box plane selection switches S1R and S23 is controlled from the gear-box so that it is closed only when neutral is selected in the gear-box. Thus in a gear change, for example from high first to low second, no signal appears on line L23 until neutral has been selected in the gear-box.

Similarly, a "plane selected" switch PS, shown as two separate switches PS1 and PS2, prevents a signal reaching the lines for selecting in-gear fore and aft positions until the signalled gear-box plane has been selected. The switch PS is also controlled from the gear-box. For example, continuing the change from high first to low second it is only after the 2—3 gear-box plane has been selected that switch PS2 is closed and a signal is given on line L2R4 to engage second gear.

Missing intermediate Ratios in a gear change.

It is possible to miss out some ratios in a gear change sequence. For example it is possible to change directly from gear H5 to gear L1, or from gear H2 to gear L4. This is because in any gear change which involves a ratio change in the gear-box, neutral is always selected before the new ratio is selected. For example, in changing from H5 to L1, neutral is selected as soon as the selector lever 21 is moved out of H5; in changing from H2 to L4 neutral is selected by means of the selector bar BN as the selector lever 21 is moved between the L2—H2 plane and the L3—H3 plane.

Once neutral has been selected the gear-box can respond to any selection of gear ratio.

Modifications with "wide ratio fourth gear".

The arrangement described above should be used only where fourth and fifth gear-box ratios are close together so that L5 is lower than H4. If a gear-box with "wide ratio fourth gear" is used then the sequence for increasing ratios on the upper ratios will be L4, H4, L5, H5. With such an arrangement the two ratios L4 and H4 would occupy one plane and ratios L5 and H5 would occupy another plane. Thus neutral selection within one of the higher ratio planes would not be required and the relay R45 and associated neutral selection equipment (e.g. line LGBN) would not be required. The selector bars would of course have to be modified to provide selection of the correct ratios. Provision would be required for selection of neutral in a gear-change from the L4—H4 plane to the L5—H5 plane; this could be an extension of the selector bar BN to between these two planes and an additional projection 26 on this extended selector bar.

It would also be possible to dispense with the selector bar BN and the switch SN. The supply to the bank of switches S2R4 and S135 would then be to the supply terminal of switch S2R4. The open output from the switch S135 would serve for the neutral signalling line LN. With this arrangement, when no gear ratio is engaged and thus neither switch S2R4 nor switch S135 is operated a signal would reach the line LN through the two switches S2R4 and S135 and neutral would be selected.

Modifications with 4-speed gear box.

With a four-speed gear-box instead of a five speed gear-box the modified form of control system used with a "wide ratio fourth" five speed gear-box could be further simplified. Because the gear-box gate with a four speed gear-box has an R plane, a 1—2 plane and a 3—4 plane instead of an R—1 plane a 2—3 plane and a 4—5 plane extensive alterations to the layout would be required. The simplest way to explain the necessary modifications required would be to treat ratios 1, 2, 3 and 4 of the four-speed gear-box as ratios 2, 3, 4 and 5 respectively of the five speed gear-box and remove the L1—H1 plane and its associated parts from the gate shown in Figure 3 as modified for use with a "wide ratio fourth" gear-box.

Modifications for High and Low reverse gears.

In the arrangement as shown in Figure 3, or with any of the possible modifications it would be possible to provide a high ratio reverse gear HR. The gate would have to be modified to provide for movement in both directions in the R plane and the selector bars BHB and B2R4B would have to be extended to the reverse plane.

The following specifications have been considered since this specification was filed, 817260, 709249, 591153.

WHAT WE CLAIM IS:—

1. A motor vehicle transmission having all the following characteristics in combination:

a) the transmission incorporates a first variable speed ratio device capable of driving with any of more than one forward speed ratio and a reverse speed ratio;

b) a second variable speed ratio device is arranged in series with the first variable speed ratio device and is capable of driving with any of more than one forward speed ratios;

c) the operative speed ratio of the first variable speed ratio device in the transmission is controllable by electrical signals;

d) the operative speed ratio of the second variable speed ratio device in the transmission is controllable by electrical signals; and

e) a control system is adapted to provide electrical signals to control the operative gear ratios in both variable speed ratio devices by movement of a single manually operable control in the control system between a series of discrete positions each corresponding to a respective overall gear ratio.

2. A transmission as claimed in claim 1 in which the second variable speed ratio device is a two-speed device.

3. A transmission as claimed in claim 2 in

which the two-speed device is a two-speed axle.

4. A transmission as claimed in claim 2 or claim 3 in which the first variable speed ratio device is a gear-box with a plurality of forward speed ratios and a reverse speed ratio.

5. A transmission as claimed in claim 4 in which a gear-box selector lever is operated by two electrically controlled servos which move the selector lever into discrete positions in each of which a particular gear ratio is selected.

6. A transmission as claimed in claim 5 in which one of the servos moves the gear-box selector lever fore and aft and the other moves the gear-box selector laterally.

7. A transmission as claimed in claim 6 in which the control system has a selector lever which is movable in a gate which has a series of gate positions each of which corresponds to an overall transmission ratio of the transmission.

8. A transmission as claimed in claim 7 in which the control system has three sets of signal lines, one to the two-speed device, one to the servo which moves the gear-box selector fore and aft and one to the servo which moves the gear-box selector laterally.

9. A transmission as claimed in claim 8 in which signals on the signal lines are controlled by switches which are in turn operated by selector bars and in which the selector bars are selectively operated by moving the control system selector lever into a gate position corresponding to an overall gear ratio.

10. A transmission as claimed in any of claims 7 to 9 in which: there are five forward gear-box speed ratios; the overall ratios are in the sequence: low first, high first, low second, high second, low third, high third, low fourth, low fifth, high fourth and high fifth; and the gate is arranged with the forward "in gear" positions as shown in Figure 2 of the accompanying drawings.

11. A transmission as claimed in claim 10 in which the portions of the gate between the forward gear ratio portions are staggered as shown in Figure 2 of the accompanying drawings.

12. A transmission as claimed in any of claims 7 to 11 in which ratio changes within a plane of the gate which require a change in axle ratio but not in gear-box ratio are effected without selecting neutral as the control system selector lever moves through the centre of the plane.

13. A transmission as claimed in claim 12 in which to select neutral from a plane in which both ratios involve the same gear-box ratio the control system selector lever is moved across the gate towards another plane.

14. A transmission as claimed in any of claims 7 to 13 in which when ratio changes within a plane of the gate involve a change in gear-box ratio, neutral is automatically selected when the control system selector lever is moved out of gear.

15. A transmission as claimed in claim 14 as appended to claim 10 in which the control system is such that neutral is selected when the fourth-fifth gear-box plane is selected and no switch is operated for fore or aft gear-box position selection.

16. A transmission as claimed in claim 9 in which: the switches are arranged in groups so that one group controls the axle ratio, another controls the gear-box plane selected and the other controls the fore and aft position within a gear-box plane; the switches are change-over switches with an input, an open output which is energised when the switch is unoperated, and a closed output which is energised when the switch is operated; the supply to a first switch in a group is from outside the group of switches and the supply to each subsequent switch in the group is from the open output of the preceeding switch; in at least one group of switches there is one switch less than the number of signal lines in the group, all but one of the signal lines being connected to a closed output of a switch and the ramaining signal line being connected to the open output of the last switch so that it is energised when all the switches are open.

17. A transmission as claimed in claim 5 or any of claims 6 to 16 as appended to claim 5 in which in the absence of a signal applied to the servos the gear-box selector lever remains in its current position and in which a master switch controls the electrical supply to the control system so that current is supplied only during a gear change.

18. A transmission as claimed in claim 17 in which the master switch is operated by manual pressure from the vehicle driver on a control knob attached to the control system selector lever.

19. A transmission as claimed in claim 17 or claim 18 in which an over-ride switch is connected in parallel with the master switch and is rranged to remain closed until a gear selection has been completed even if the master switch is opened, by removal of the driver's hand, before gear selection has been completed.

20. A transmission as claimed in claim 6 or any of claims 7 to 19 as appended to claim 6 in which a "neutral selected" switch is energised when neutral has been selected in the gear-box and in which this neutral selected switch prevents selection of a plane in the gear-box until neutral has been selected and the switch is energised.

21. A transmission as claimed in claim 6 or any of claims 7 to 20 as appended to claim 6 in which a "plane selected" switch is energised when a signalled plane has been selected

in the gear-box and in which this switch prevents fore and aft movement of the gear box selector lever until the plane has been selected and the switch energised.

22. A motor vehicle transmission substantially as described with reference to and as shown in the accompanying drawings.

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Chartered Patent Agent.

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Sheet 1

Fig.1.

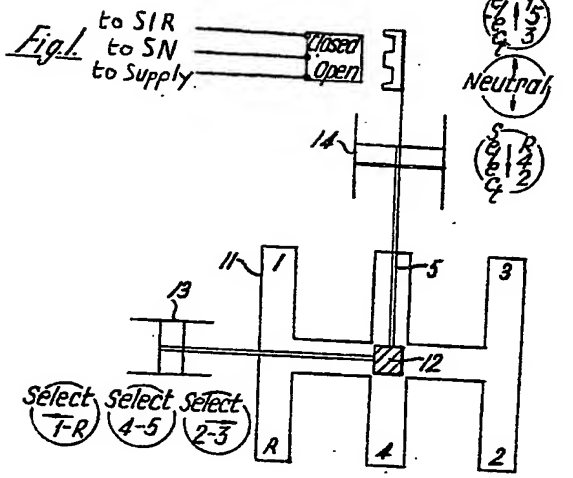


Fig.4.

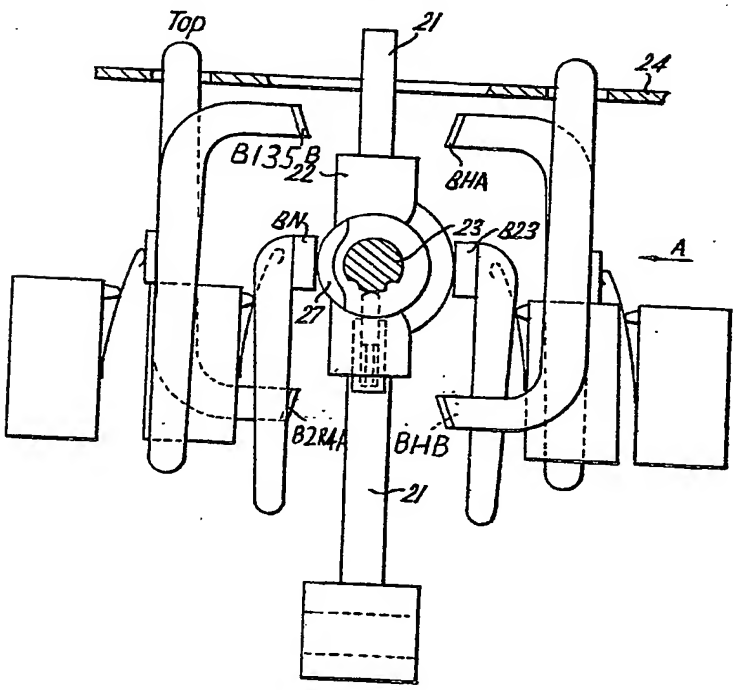
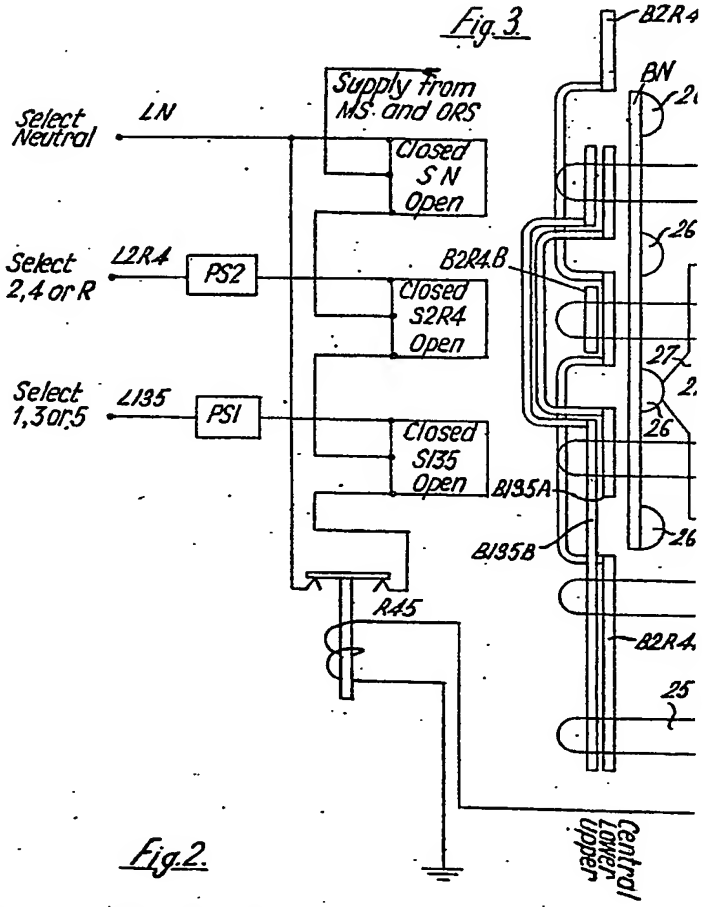


Fig. 3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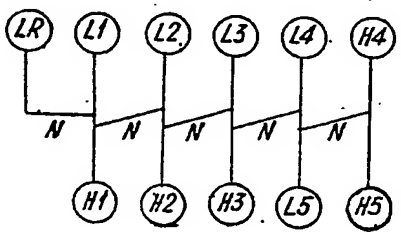
26
27
Central Lower upper

Fig. 2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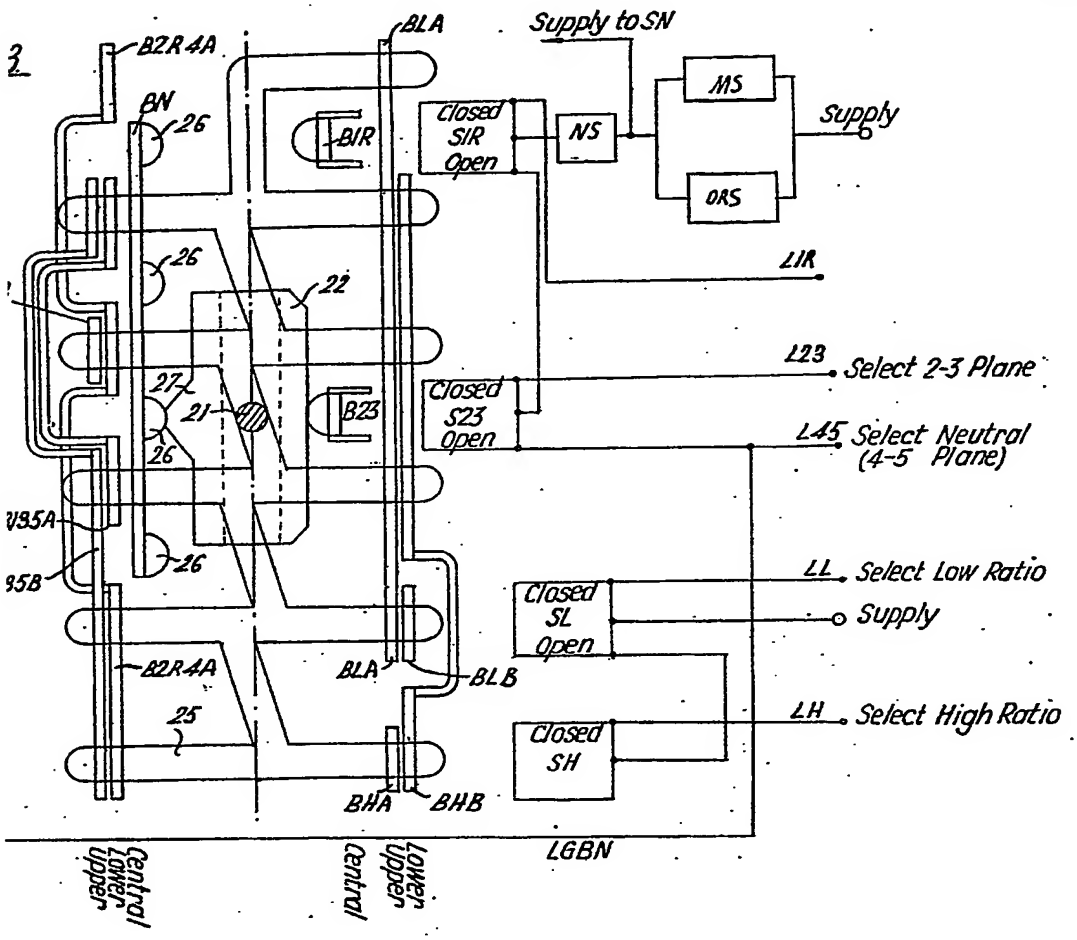

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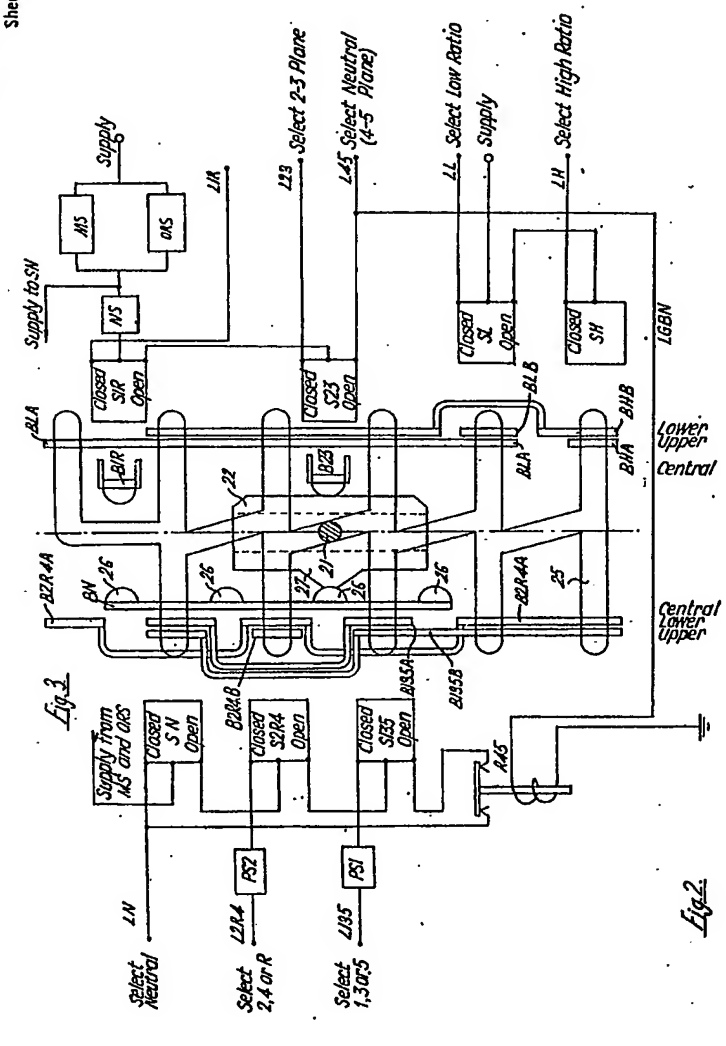

Fig 1

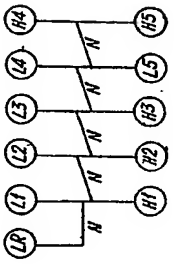

Fig 2

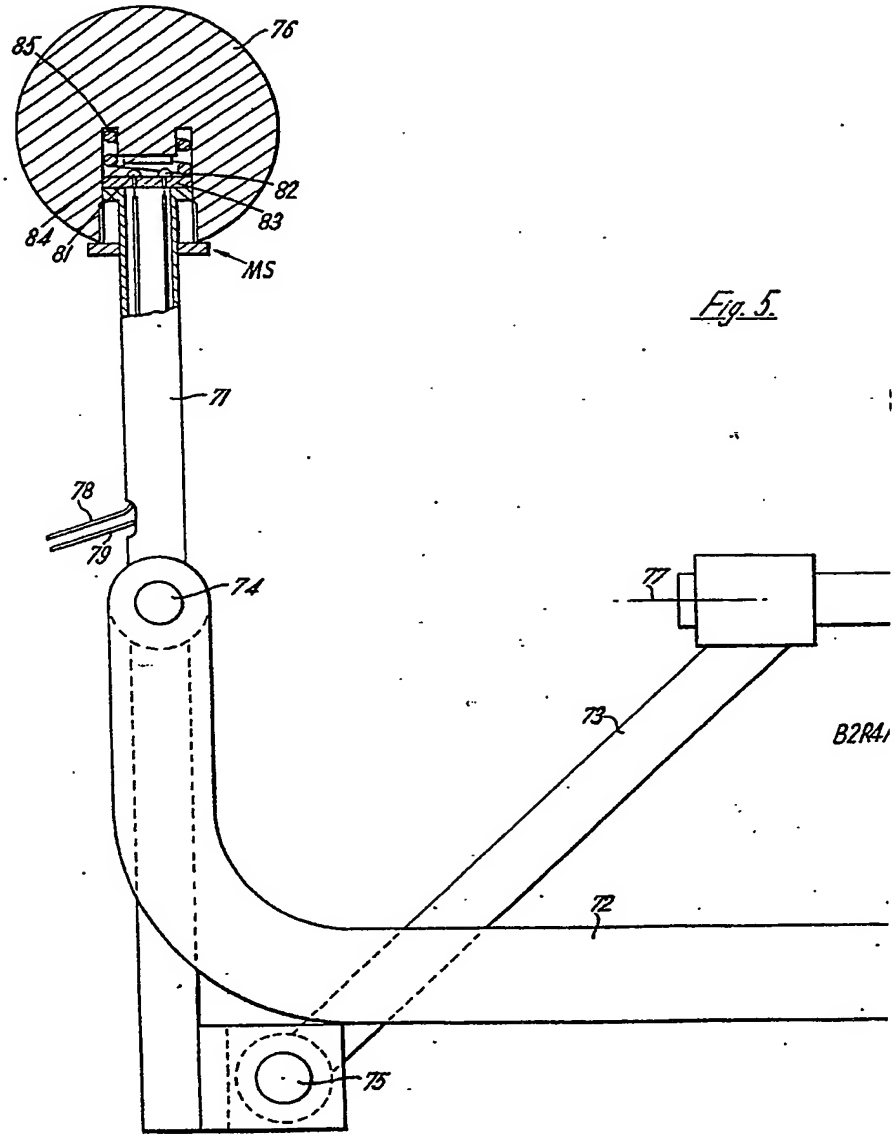

Fig. 5.

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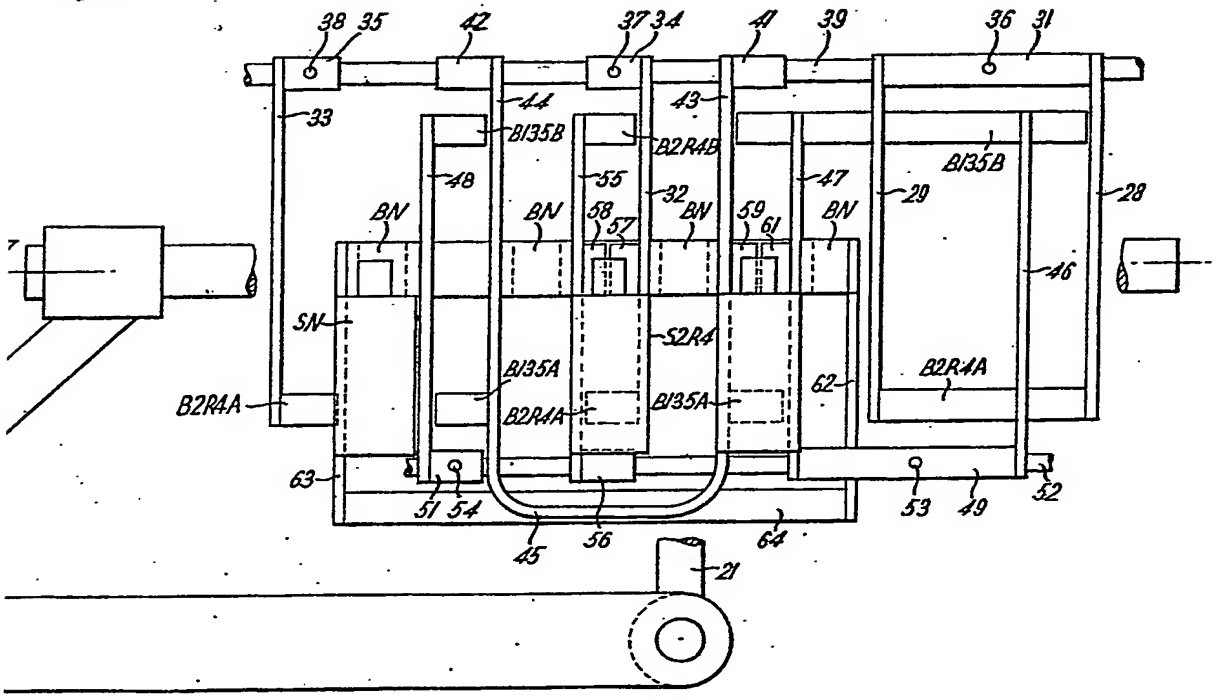
Fig. 5.



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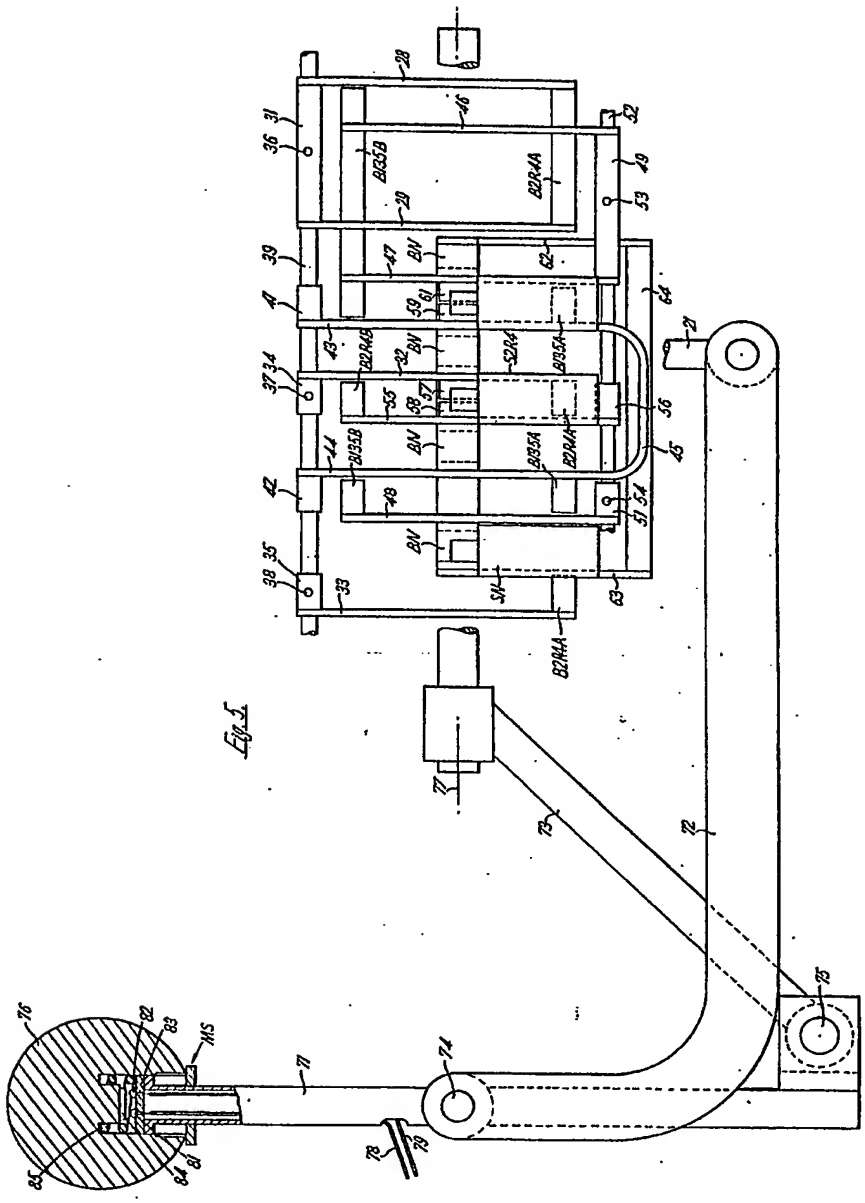

Fig. 1